

# Omaha Public Power District Fuel Cell Energy at the Henry Doorly Zoo

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Group  
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# History of Fuel Cell Technology

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- First Fuel Cell developed in 1839 by Sir William Grove
- First practical use - space program in 1960's
- UTC Fuel Cells PC25 commercial units available since mid-1990's
- Over 200 units currently in operation worldwide

# Henry Doorly Zoo Project

## Summary

- Installed as a technology demonstration
- Model PC25C fuel cell commissioned on 8/8/01
- Supplied by UTC Fuel Cell - East Windsor, Connecticut
- Installed at Lied Jungle
- 200 kW unit serves 50% of power needs of Lied Jungle
- Installation Complete - August, 2001

# Design Objectives

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- Supply power to critical Jungle systems
- OPPD grid is backup power
- Low temp heat used to temper cold water
- High temp heat used to supplement boilers

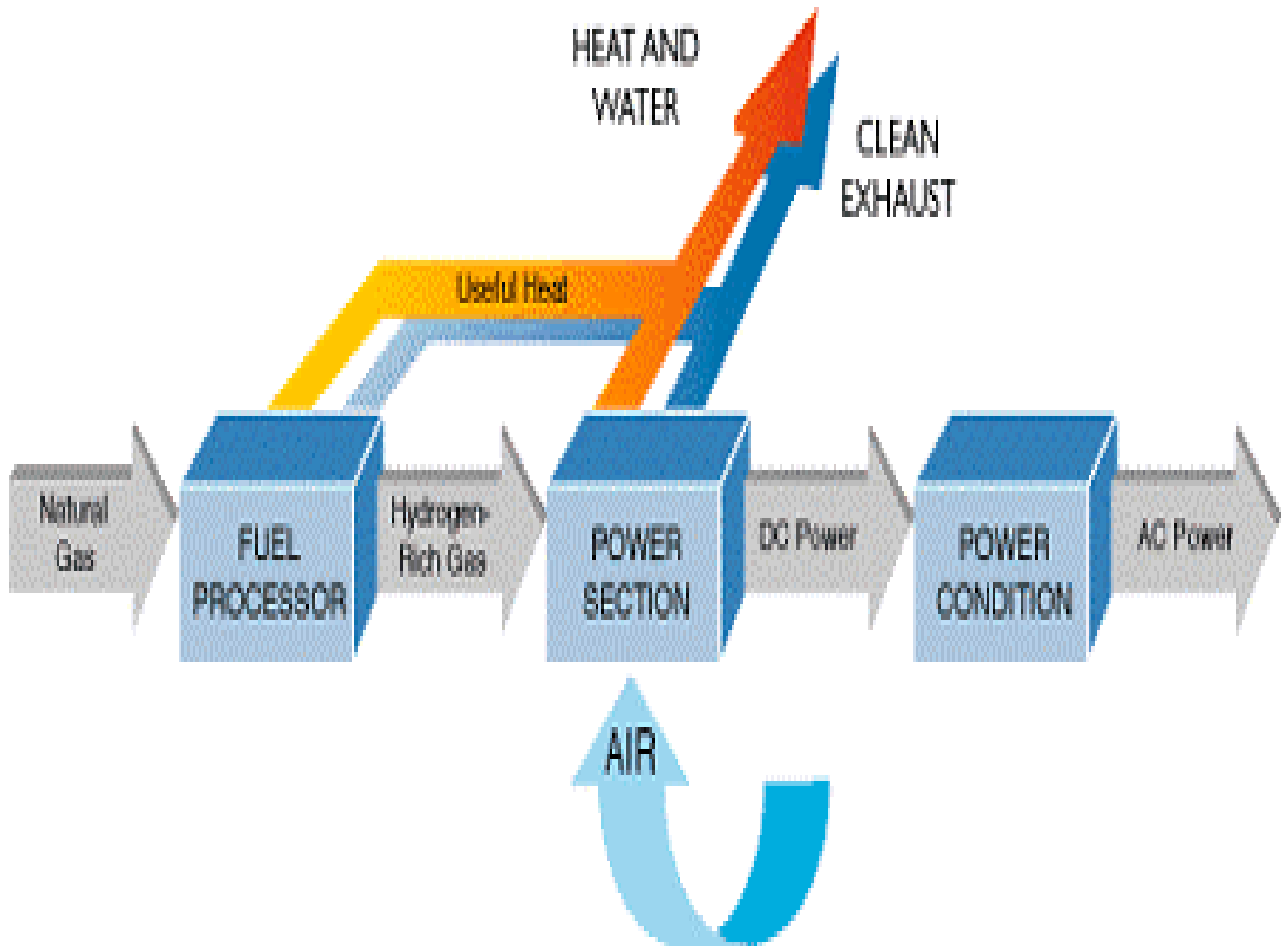












# How it works



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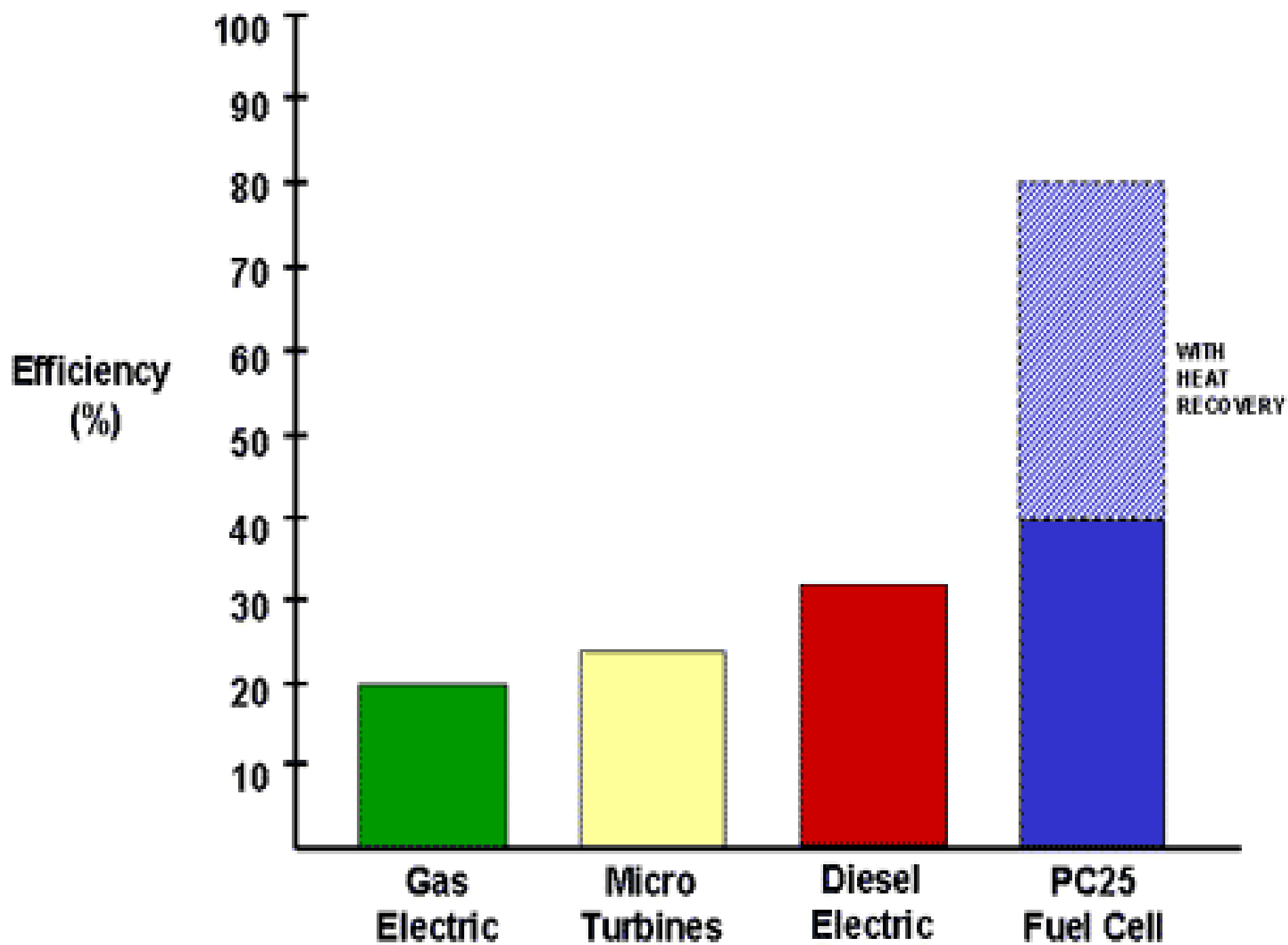
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- Hydrogen is removed from NG
- Hydrogen protons pass through cell membrane
- Electrons pass around membrane creating DC circuit
- Oxygen combines with hydrogen protons to form water
- Fuel cell produces electricity, heat, and water

# Fuel Cell Advantages

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- **Minimal environmental impact**
- **High efficiency w/waste heat recovery**
- **Provides premium power and increased reliability**



# Emissions and Sound

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- 1 ppm Nitrogen Oxides (NO<sub>x</sub>)
- 5 ppm Carbon Monoxide (CO)
- Negligible Sulfur Oxides (SO<sub>x</sub>)
- Negligible particulates
- No smoke
- Noise - 62 decibels (dBA) at 30 feet

# Operating Data

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● Peak Output	200 kW @ 480v
● Annual Generation	1,314,000 kWh
● Capacity Factor	75%
● Heat Rate	9500 Btu/kWh
w/Waste Heat	6000 Btu/kWh
● Fuel Consumption	12,483 MBtu/yr
● Waste Heat	4,599 MBtu/yr

# Construction Costs

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● Fuel Cell	\$ 840,000
● Installation	\$ 252,000
● HDR Engineering	\$ 85,000
● Project Management	\$ 36,000
● Financing	<u>\$ 16,000</u>
● TOTAL Cost	\$1,229,000



# Net Cost with DOE Grant

● Total Costs	\$1,229,000
● DOE Grant	<u>(\$ 200,000)</u>
● NET COST	\$1,029,000
● Cost per kW	\$5,145/kW

# Annual Costs

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● Carrying Costs	\$ 81,600 (5.5%, 20 yr)
● O&M	\$ 26,000
● Fuel	<u>\$ 37,400 (\$3/mmBtu)</u>
● TOTAL COST	\$145,000
● Waste Heat	<u>(\$14,000)</u>
● NET COST	\$131,000

# Annual Energy Cost

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- **Annual Cost**            **\$131,000**
- **Generation\***            **1,314,000 kWh**
- **Busbar Cost\*\***        **10 cents/kWh**

**\* Based on 75% capacity factor**

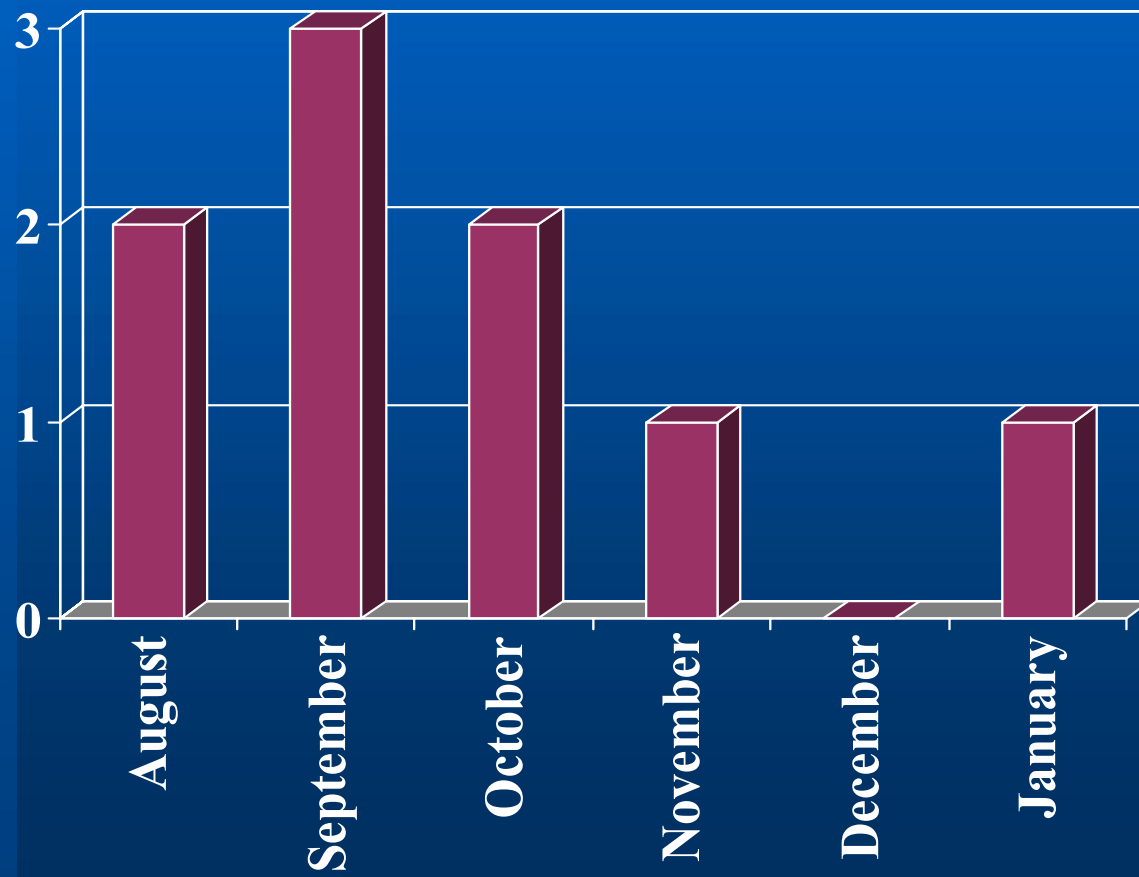
**\*\* Compares with oil-fired turbine**

# Rate Comparison

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- **OPPD Average Rate**      **5.5 c/kWh**
- **Green Rate**      **4 - 6 c/kWh**
- **Premium Power**      **0 - 1 c/kWh**
- **TOTAL**      **9.5 - 12.5 c/kWh**
  
- **FUEL CELL**      **10 c/kWh**

# Unit Trips



# Performance Statistics

8-8-01 and 1-31-02

- **Availability - 50 %**
- **Capacity factor - 47.9 %**
- **Electrical Efficiency - 30 %**
- **Overall Efficiency - 34 %**

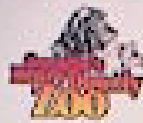
# Other Issues

- N2 content of gas. 4% limit. About 6-7% most time.
- Have to dispose of inferior gas if gas is scrubbed.
- Need steady load. Follows 10kw/sec load variations well. Up and down not well.
- Optimize thermal use in zoo.

CLEAN EMISSIONS

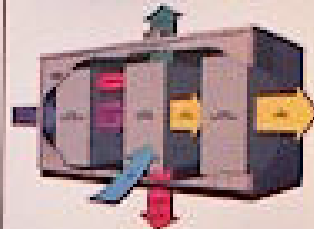
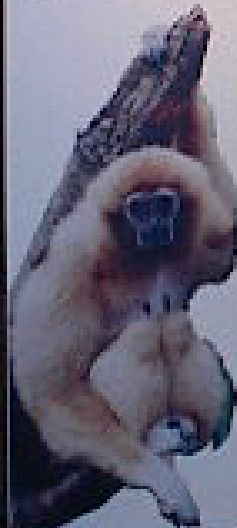
COMPUTER GRADE POWER  
NEW TECHNOLOGY

# FUEL CELL



## Fuel Cell at the Zoo

- In a five-year demonstration project, new fuel cell technology is providing electricity and heat to the San Diego Zoo's San Diego Zoo.
- The fuel cell will handle about 80% of the San Diego Zoo's electrical load in the summer and about 40% in the winter.
- As it generates electricity, the fuel cell also creates heat, which is used to warm the tropical ponds in the jungle.



## Now Technology at Work

- A fuel cell is an electrochemical device that combines hydrogen and oxygen gas and converts them into electricity.
- Since the fuel is converted directly to electricity, a fuel cell has no moving parts, no heat, higher efficiency than combustion engines, and no emissions.



## Fuel Cell Facts

- A fuel cell is similar to a battery in operation in standard batteries. Like a battery, fuel cells produce power from chemical reactions rather than combustion and they do not produce excessive air pollution.
- More than 100 of these fuel cell power plants are operating in 20 states throughout the United States as well as across other countries.
- The 2000 Summer fuel cell stack provides the electric power needs of about 100 homes.
- This technology works in a wide variety of fuel cells. A fuel cell can also be operated in a computer system.

Keeping the





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